Is intake of 100% fruit juice related to adiposity in children?

Conclusion

Limited and inconsistent evidence suggests that for most children, intake of 100% fruit juice is not associated with increased adiposity, when consumed in amounts that are appropriate for age and energy needs of the child. However, intake of 100% juice has been prospectively associated with increased adiposity in children who are overweight or obese.

Grade: Limited

Overall strength of the available supporting evidence: Strong; Moderate; Limited; Expert Opinion Only; Grade not assignable For additional information regarding how to interpret grades, click here.

Evidence Summary Overview

This conclusion is based on a full Nutrition Evidence Library (NEL) literature search (2004 to 2009), supplemented by the findings of prospective studies included in an earlier evidence review conducted by the American Dietetic Association (ADA) (1982 to 2004). In combination, the two systematic literature searches identified 12 peer-reviewed prospective studies that addressed the research question and met the inclusion criteria (Alexy, 1999; Berkey, 2004; Blum, 2005; Faith, 2006; Field, 2003; Kral, 2008; Libuda, 2007; Newby, 2004; Skinner, 1999; Skinner, 2001; Sugimori, 2004; Welsh, 2005). Nine studies were conducted in the US, two in Germany, and one in Japan. Overall, of the 12 cohort studies, eight studies found no association between intake of fruit juice and adiposity in children (Alexy, 1999; Berkey, 2004; Blum, 2005; Field, 2003; Kral, 2008; Newby, 2004; Skinner, 1999; Skinner, 2001); two found no association between intake of fruit juice and adiposity in normal weight children, but found a positive association for children who were at-risk ofoverweight or who were overweight at baseline (Faith, 2006; Welsh, 2005); and two studies found mixed results by sex. Libuda et al (2007) found no association for boys, but a positive association for girls, while Sugimori et al (2004) found no association for girls, but a positive association for boys.

Overall, the preponderance of evidence led to the conclusion that for most children 100% fruit juice intake and adiposity are not associated. Two of the studies, however, found a positive association between 100% fruit juice intake and adiposity among overweight and obese children (Welsh, 2005; Faith, 2006). These findings are of concern because about one-third of US children and adolescents are currentlyoverweight or obese. Therefore, it is recommended that 100% juice be consumed in moderation, as part of a nutrient-rich, energy-balanced diet, in amounts are appropriate for the overall energy needs and nutrient requirements of the child.

Evidence Summary Paragraphs

Cohort Studies (12)

Alexy U et al, 1999 (positive quality) analyzed data from a prospective cohort study in Germany to examine the association between consumption of fruit juice and weight. Children were from the Dortmund Nutritional and Anthropometrical Longitudinally Designed Study (DONALD). Children

were followed over a period of two years from age three to five years, and had height and weight measured, and diet assessed via a three-date weighed diet record. The final sample included 205 children (105 boys, 100 girls; age three at baseline). In 9% of all diet records, fruit juice intake exceeded 12fl oz per day, and none of these children were obese. In addition, body mass index (BMI) did not correlate with consumption of fruit juice.

Berkey CS et al, 2004 (neutral quality) used prospective cohort data from the US to evaluate the relationship between changes in BMI over time and consumption of beverages, including fruit juice. Subjects were participants in the Growing Up Today Study (GUTS), and were nine to 14 years old baseline. Children self-reported their height and weight, and provided dietary intake data via a food frequency questionnaire (FFQ). Follow-up occurred over two one-year periods. The final sample included 16,771 children. Energy-adjusted analyses showed no significant relationships between fruit juice intake and BMI change in either boys or girls.

Blum JW et al, 2005 (neutral quality) used prospective cohort data from the US to determine differences in beverage consumption from baseline to year two follow-up in all subjects and based on BMI z-scores and identify predictors of BMI z-score at year two. Subjects were categorized into four groups based on BMI z-score at baseline: 1) Normal weight, BMI z-score less than 1.0 at baseline and year two; 2) Overweight, BMI z-score of 1.0 or more at both baseline and year two 3) Gained weight, BMI z-score of less than 1. 0 at baseline and a BMI z-score of 1.0 or more at year two; and 4) Lost weight, BMI Z-score of 1.0 or more at baseline and a BMI z-score of less than 1.0 at year two. A 24-hour diet recall was used to determine total caloric intake and beverage consumption at baseline and year two. The final sample included 166 children (92 girls, 74 boys; age 9.3 years at baseline and 10.7 at year two). Results showed no significant (NS) change in 100% juice consumption between baseline and year two in all subjects or any of the BMI z-score groups; in regression analyses, 100% juice consumption did not account for variance in BMI z-score. These results do not support an association between 100% fruit juice and BMI.

Faith et al, 2006 (neutral quality) used a prospective cohort design study to test whether increased fruit juice intake was associated with adiposity among children participating in the Women, Infants and Children (WIC) program in New York. Questionnaires were given to parents attending WIC clinics, which included questions on the usual number of servings per day of fruit juice that the child consumed. Each child's most recent height or length, weight and date of measurement were abstracted from his or her WIC chart at the time of the survey. Additional data to compare to baseline were obtained for each study child beginning in December 2001 to September 2002 by abstracting height, weight and measurement data from WIC charts. The final sample included 971 children (mean age at baseline was 30 months). There was a significant overweight status by fruit juice interaction (P=0.01), such that for children who were at risk of or overweight at baseline, each additional daily serving of fruit juice intake was associated with an additional BMI Z-score gain of 0.009 SD per month (P<0.01), and boys showed a greater adiposity gain than girls (P=0.04).

Field et al, 2003 (positive quality) used data from a prospective cohort study to assess whether intake of fruits and vegetables and fruit juice were associated with change in BMI among a large sample of children and adolescents in the US. Participants completed at least two questionnaires between 1996 and 1999 as part of the Growing Up Today Study (GUTS). Fruit, vegetable and fruit juice intake were assessed with the Youth/Adolescent Questionnaire (YAQ), a self-administered semi-quantitative FFQ assessing intake of 131 foods over the past year. Weight Status was determined using BMI that was calculated using self-reported height and weight, and was based on age- and gender-specific Centers for Disease Control and Prevention (CDC) growth charts. The final sample included were 8,203 girls and 6,715 boys who were ages nine to 14 years in 1996. Results were adjusted for age, Tanner stage, activity, inactivity, age- and gender-specific z-score of BMI at

baseline, height change and total energy intake. Results showed that on average, girls and boys consumes slightly fewer than two servings of fruit per day, of which almost 50% was in the form of juice, and fewer than 25% of the participants were meeting the recommendation to consume at least five servings of fruits and vegetables per day. There were no significant associations between intake of fruit juice and subsequent changes in BMI z-score among girls or boys (adjusted for Tanner stage, age, height change, activity, inactivity and total energy intake).

Kral et al, 2008 (neutral quality) used a prospective cohort design to test whether changes in beverage consumption patterns from age three to six years were associated with changes in children's BMI z-score and waist circumference (WC). Beverage intake was assessed using three-day weighed food records and was stratified into seven categories: Milk and milk-based beverages; 100% fruit juice; fruit drinks; soda; diet soda; soft drinks (soda, diet soda and fruit drinks combined); soft drinks and fruit juice (soda, diet soda, fruit drinks and fruit juice combined). Height and weight were measured by study personnel yearly. The final sample included 45 subjects (25 boys, 20 girls). Results showed no significant associations between change in consumption of 100% fruit juice from individual beverage categories and change in BMI z-score. Also, over the study time period, greater increases in calories ($P<0.02$) and percent energy ($P<0.02$) consumed from all types of beverages was inversely related to changes in children'sWC. This study showed no association between 100% fruit juice consumption and adiposity in children from ages three to five years.

Libuda et al, 2007 (neutral quality) used a prospective cohort design study to test for an association between beverage consumption and body-weight status as part of the DONALD (Dortmund Nutritional and Anthropometric Longitudinally Designed) study using data from subjects aged nine to 18 years collected over a five-year period. Beverage intake was assessed using three-day weighed food records, and was grouped as follows: Regular soft drinks; diet soft drinks; 100% fruit juice; and energetic beverages (regular soft drinks and fruit juice combined). Body weight and height were measured to calculate BMI. The final sample included 244 subjects (125 boys, 119 girls; mean age = 12 years at baseline). In boys, a higher intake of fruit juice at baseline was associated with a higher baseline BMI-SDS ($P<0.05$). In girls, change in beverage intake significantly predicted change in BMI-SDS; for each additional mJ of energetic beverage consumed, BMI-SDS of girls increased by 0.07 units ($P=0.01$), and for each MJ of fruit juice consumed, BMI-SDS increased by 0.096 units ($P=0.01$). This study showed a relationship between consumption of 100% fruit juice and increased BMI over time in girls, and positive cross-sectional association between 100% fruit juice consumption and BMI-SDS at baseline in boys.

Newby PK et al, 2004 (positive quality) analyzed prospective cohort data from the US to examine the relationship between diet and weight in children. Subjects were from the North Dakota WIC program, and were aged two to five years at baseline. Children included in these analyses had at least two clinic visits, which were about one year apart. Height and weight were measured and BMI was calculated. Dietary data was collected using an FFQ. The final sample included 1,345 children (mean age = three years). Results showed no significant (NS) relationship between consumption of fruit juice and weight change.

Skinner JD et al, 1999 (positive quality) analyzed data from a prospective cohort study in the US to investigate whether excess fruit juice intake was associated with obesity in preschool children. Mothers were interviewed twice when children were age 24, 28 or 32 months, and when children were age 28, 32 or 36 months. At each interview, mothers provided a three-day diet record, and the child was weighed and measured. Children consuming less than 12oz per day of juice were compared to children consuming more than 12oz per day. The final sample included 105 children (52% boys; age range 2.0 to 2.7 years). Results showed NS relationship between excess fruit juice consumption (more than 12oz per day) and BMI.

Skinner JD and Carruth BR, 2001 (positive quality) analyzed prospective cohort data from the US to determine whether children's longitudinal juice intake was associated with growth parameters at age 72 months. Mothers were interviewed twice when children were age 24, 28 or 32 months, and when children were age 28, 32 or 36 months. All children were also interviewed at months 42, 48, 54, 60 and 72. At each interview, researchers collected three days of dietary date (24-hour recall, two days of food records) and the child was weighed and measured. The final sample included 72 children (37 boys, 35 girls). Results showed NS relationship between fruit juice consumption and weight status.

Sugimori H et al, 2004 (neutral quality) used data from a prospective cohort study to elucidate both environmental and behavioral factors that influence BMI among Japanese children from ages three to six. Children were assessed at baseline, age three years, and follow-up for three years to age six. Height and weight were measured and used to determine BMI and weight status, and diet was assessed using a questionnaire. Children were categorized into four groups: Group one, normal at both age three years and six years (normal/normal); group two, overweight at age three years and normal at age six years (overweight/normal); group three, normal at age three years and overweight at age six years (normal/overweight); and group four, overweight at both age three years and six years (overweight/overweight). The final sample included 8,170 subjects (4,176 boys, 3,994 girls; age three years at baseline). There were NS associations found between fruit juice consumption and weight change over three years.

Welsh JA et al, 2005 (positive quality) conducted a longitudinal cohort design study in the US to examine the association between sweet drink consumption, including fruit juice, and overweight among preschool children participating in the WIC program. Dietary intake data was collected at baseline with the Harvard FFQ, modified and validated for youth. For this study, "sweet drinks" included all sugar-sweetened and naturally sweetened drinks listed on the FFQ, "vitamin C juice" (orange juice or juice with vitamin C added) and "other juices,", "fruit drinks (Hi-C, Kool-Aid, lemonade)," and "soda [soda, soft drink, pop (not sugar-free)]." Separate analyses assessed the relation to adiposity for the: 1) Combined "sweet drinks"; 2) for sweet drinks excluding soda; and 3) for fruit juice alone (vitamin-C-containing and other). Measured height and weight were used to calculate BMI for each participant at baseline and at follow-up, one year (11 to 13 months) later. The final sample included 10,904 children (50% female; 89% white, 6% black; 10% overweight and 14.5% at risk of overweight). Results showed that the strength of the association between consumption of "sweet drinks" and overweight at follow-up varied with baseline BMI, with no association for children who were normal weight or underweight at baseline, but a significant positive association for children who were overweight or at-risk of overweight at baseline. There was no association of fruit juice intake with adiposity at follow-up for children who werenormal weight or underweight at baseline (odds range 0.8 to 1.2), but there was a positive association for children who were overweight or at risk of overweight at baseline (odds range 1.3 to 1.5), which was of borderline significance.

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Author, Year, Study Design, Class, Rating	Participants	Methods	Outcomes

Alexy U, Sichert-Hellert W et al, 1999 Study Design: Prospective Cohort Study Class: B Rating:	N=205 (105 boys, 100 girls). Age at baseline: Three years. Location: Germany.	Children were followed over a period of two years from age three to five years and had height and weight measured and diet assessed via a three-date weighed diet record.	In 9% of all diet records, fruit juice intake exceeded 12fl oz per day and none of these children were obese. In addition, BMI did not correlate with consumption of fruit juice.
Berkey CS, Rockett HRH et al, 2004 Study Design: Cohort study (longitudinal, prospective) Class: B Rating:	N=16,771 children. Location: US.	Children self-reported their height and weight, and provided dietary intake data via a FFQ. Follow-up occurred over two one-year periods	Energy-adjusted analyses showed NS relationships between fruit juice intake and BMI Δ in either boys or girls.
Blum JW, Jacobsen DJ et al, 2005 Study Design: Prospective Cohort Study Class: B Rating:	N=166 (92 girls, 74 boys). Age: 9.3 years at baseline; 10.7 years at year two. Location: US.	Subjects were categorized into four groups based on BMI z-score at baseline: 1) normal weight, 2) overweight, 3) gained weight, and 4) lost weight. A 24-hour diet recall was used to determine total caloric intake and beverage consumption at baseline and year two.	Results showed NS Δ in 100% juice consumption between baseline and year two in all subjects or any of the BMI z-score groups; in regression analyses, 100% juice consumption did not account for variance in BMI z-score.
Faith MS, Dennison BA et al, 2006 Study Design: Prospective Cohort Study	N=971. Mean age at baseline: 30 months. Location: US.	Questionnaires were given to parents attending WIC clinics, which included questions on the usual number of servings per day of fruit juice. Each child's most recent	For children who were at risk of or overweight at baseline, each additional daily serving of fruit juice intake was associated with an additional BMI z-score ↑ of 0.009 SD per month ($P<0.01$), and boys showed a greater adiposity ↑

Class: B Rating:		height or length, weight and date of measurement were abstracted from his or her WIC chart at the time of the survey.	than girls (P=0.04).
Field A, Gillman M et al, 2003 Study Design: Prospective Cohort Study Class: B Rating:	N=8,203 girls and 6,715 boys. Age in 1996: Nine to 14 years. Location: US.	Participants completed at least two questionnaires between 1996 and 1999. Fruit, vegetable, and fruit juice intake were assessed with the Youth/Adolescent Questionnaire (YAQ), a self-administered semiquantitative FFQ. Weight status was determined using BMI that was calculated using self-reported height and weight.	There were NS associations between intake of fruit juice and subsequent Δs in BMI z-score among girls or boys (adjusted for Tanner stage, age, height Δ, activity, inactivity and total energy intake).
Kral TV, Stunkard AJ et al, 2008 Study Design: Cross-Sectional Study Class: D Rating:	N=45 (25 boys, 20 girls). Location: US.	Children were followed from age three years to age six years. Beverage intake was assessed using three-day weighed food records and was stratified into seven categories: • Milk and milk-based beverages • 100% fruit juice (FJ) • Fruit drinks (FD) • Soda • Diet soda (DS) • Soft drinks (soda, DS and FD combined) • Soft drinks • Fruit juice (soda, DS, FD and FJ	Results showed NS associations between Δ in consumption of 100% FJ from individual beverage categories and Δ in BMI z-score.

		combined). Height and weight were measured by study personnel yearly.	
Libuda L, Alexy U et al, 2008 Study Design: Prospective Cohort Study Class: B Rating: 	N=244 (125 boys, 119 girls). Mean age at baseline: 12 years. Location: US.	Data was from subjects aged nine to 18 years collected over a five-year period. Beverage intake was assessed using three-day weighed food records and was grouped as follows: • Regular soft drinks • Diet soft drinks • 100% fruit juice (FJ) • Energetic beverages (regular soft drinks and FJ combined). Body weight and height were measured to calculate BMI.	In boys, a ↑ intake of fruit juice at baseline was associated with a ↑ baseline BMI-SDS ($P<0.05$). In girls, Δ in beverage intake significantly predicted Δ in BMI-SDS; for each additional MJ of energetic beverage consumed, BMI-SDS of girls ↑ by 0.07 units ($P=0.01$), and for each MJ of FJ consumed, BMI-SDS ↑ by 0.096 units ($P=0.01$).
Newby PK, Peterson KE et al, 2004 Study Design: Cohort study (longitudinal, retrospective) Class: B Rating: 	N=1,345. Mean age: Three years. Location: US.	Children included in these analyses had at least two clinic visits, which were about one year apart. Height and weight were measured and BMI was calculated. Dietary data was collected using an FFQ.	Results showed NS relationship between consumption of fruit juice and weight Δ.
Skinner JD, Carruth BR 2001 Study Design:	N=72 (37 boys, 35 girls). Location: US.	Mothers were interviewed twice when children were age 24, 28 or 32 months, and when children were age 28, 32	Results showed NS relationship between fruit juice consumption and weight status.

Cohort Study Class: B Rating: 		or 36 months. All children were also interviewed at months 42, 48, 54, 60 and 72. At each interview, researchers collected three days of dietary date (24-hour recall, two days of food records), and the child was weighed and measured.	
Skinner JD, Carruth BR et al, 1999 Study Design: Cohort Study Class: B Rating: 	N=105 (52% boys). Age range: 2.0 to 2.7 years. Location: US.	Mothers were interviewed twice when children were age 24, 28 or 32 months and when children were age 28, 32 or 36 months. At each interview, mothers provided a three-day diet record and the child was weighed and measured. Children consuming <12oz per day of juice were compared to children consuming >12oz per day.	Results showed NS relationship between excess fruit juice consumption (>12oz per day) and BMI.
Sugimori H, Yoshida K et al 2004 Study Design: Cohort (longitudinal, prospective) Class: B Rating: 	N=8,170 (4,176 boys, 3,994 girls). Age at baseline: Three years. Location: Japan.	Children were assessed at baseline, age three years and follow-up for three years to age six. Height and weight were measured and used to determine BMI and weight status and diet was assessed using a questionnaire.	There were NS associations found between fruit juice consumption and weight Δ over three years.

Welsh JA, Cogswell ME et al, 2005 Study Design: Retrospective Cohort Study Class: B Rating: 	N= 10,904 (50% female). 89% white; 6% black. 10% overweight; 14.5% at risk of overweight. Location: US.	Dietary intake data was collected using an FFQ. Measured height and weight were used to calculate BMI for each participant at baseline and at follow-up, one year (11 to 13 months) later.	There was no association of fruit juice intake with adiposity at follow-up for children who were normal weight or underweight at baseline (odds range 0.8 to 1.2), but there was a positive association for children who were overweight or at risk of overweight at baseline (odds range 1.3 to 1.5), which was of borderline significance.

Research Design and Implementation Rating Summary
For a summary of the Research Design and Implementation Rating results, click here.

Worksheets

Alexy U, Sichert-Hellert W, Kersting M, Manz F, Schoch G. Fruit juice consumption and the prevalence of obesity and short stature in German preschool children: results of the DONALD study. *Journal of Pediatric Gastroenterology & Nutrition* 1999; 29: 343-249.

Berkey CS, Rockett HRH, Field AE, Gillman MW, Colditz GA. Sugar-added beverages and adolescent weight change. *Obes Res.* 2004;12:778-788.

Blum JW, Jacobsen DJ, Donnelly JE. Beverage consumption patterns in elementary school aged children across a two-year period. *J Am Coll Nutr.* 2005 Apr; 24(2): 93-98.

Faith MS, Dennison BA, Edmunds LS, Stratton HH. Fruit juice intake predicts increased adiposity gain in children from low-income families: Weight status-by-environment interaction. *Pediatrics.* 2006 Nov; 118 (5): 2,066-2,075.

Field AE, Gillman MW, Rockett HR, Colditz GA. Association between fruit and vegetable intake and change in body mass index among a large sample of children and adolescents in the United States. *Int J Obesity.* 2003; 27: 821-826.

Kral TV, Stunkard AJ, Berkowitz RI, Stallings VA, Moore RH, Faith MS. Beverage consumption patterns of children born at different risk of obesity. *Obesity.* 2008 Aug;16 (8): 1,802-1,808.

Libuda L, Alexy U, Sichert-Hellert W, Stehle P, Karaolis-Danckert N, Buyken AE, Kersting M. Pattern of beverage consumption and long-term association with body-weight status in German adolescents-results from the DONALD study. *Br J Nutr.* 2008 Jun; 99 (6): 1,370-1,379.

Newby PK, Peterson KE, Berkey CS, Leppert J, Willett WC, Colditz GA. Beverage consumption is not associated with changes in weight and body mass index among low-income

preschool children in North Dakota. *J Am Diet Assoc*. 2004; 104: 1,086-1,094.

Skinner JD, Carruth BR. A longitudinal study of children's juice intake and growth: the juice controversy revisited. *Journal of American Dietetic Association*. 2001; 101: 432-437.

Skinner JD, Carruth BR, et al. Fruit juice intake is not related to children's growth. *Pediatrics*. 1999; 103:58-64.

Sugimori H, Yoshida K, Izuno T, Miyakawa M, Suka M, Sekine M, Yamagami T, Kagamimori S. Analysis of factors that influence body mass index from ages 3 to 6 years: A study based on the Toyama cohort study. *Pediatr Int*. 2004 Jun;46(3):302-10.

Welsh JA, Cogswell ME, Rogers S, Rockett H, Mei Z, Grummer-Strawn LM. Overweight among low-income preschool children associated with the consumption of sweet drinks: Missouri, 1999-2002. *Pediatrics*. 2005 Feb; 115 (2): e223-e229.